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above-ground interactions, allelopathy, alpine, competition, ecotone, ectomycorrhizae, leaf litter, plant–soil (below-ground) interactions)

Abstract:
1. Understanding mechanisms underlying species distributions is a central theme in ecology. This study identifies factors driving spatial variation in arbuscular mycorrhizal fungi (AMF). We conducted two experiments to test whether heterogeneity in AMF colonization of alpine perennial plants across a willow-meadow ecotone is due to variation in (i) above-ground competition with willows for light (experiment 1), (ii) below-ground interactions with willows and their ectomycorrhizal fungi (EMF; experiment 1) or (iii) leaf litter deposition (experiment 2).
2. In experiment 1, we tested the above-ground interactions hypothesis by covering open meadow plots with 80% shade cloth to simulate willow shading (S). To test the below-ground interactions hypothesis we transplanted ectomycorrhizal (MW) and nonmycorrhizal willows (NW) into open meadow plots. AMF colonization of herbaceous plants in the S, MW and NW treatments was compared to colonization of plants growing in unmanipulated open meadow (OC) and willow understorey (WC) control plots. In experiment 2, we tested the leaf litter hypothesis by manipulating leaf litter deposition in open meadow and willow understorey plots. AMF and EMF colonization was compared in plots with and without leaf litter.
3. In experiment 1, AMF colonization was reduced in MW willow and WC plots compared to the other three treatments, suggesting that below-ground interactions with EMF suppressed AMF colonization of herbaceous hosts. In experiment 2, the presence of leaf litter increased EMF colonization in the open meadow and reduced AMF colonization in both open meadow and willow understorey habitats, suggesting that willow-derived leaf litter indirectly affected AMF colonization by promoting EMF colonisation.
4. *Synthesis.* Our results indicate that willows indirectly reduce AMF colonization of neighbouring herbaceous plants via feedbacks with leaf litter and EMF. These willow-mediated effects could alter the distribution of mycorrhizal fungi in alpine communities, which could in turn impact the fitness and distribution of closely associated host species. Ultimately, this study demonstrates the potential for below-ground interactions to drive variation in species associations across ecotonal boundaries.